The exam will include definitions, some other short-answer questions such as true-false or answering a question about a given graph or combinatorial setup, and some proofs. I won’t ask you to give proofs of theorems proved in the textbook, but you should be able to use the techniques used in those proofs. You’ll have the whole class period (but people who come late won’t get extra time without a very good reason). No notes, books, or electronic devices can be used during the exam.

The exam will cover the material from Section 1.4 through 1.4.3, Sections 1.5.1, 1.5.2, and 1.5.4, Section 1.6, and Chapter 2 through section 2.5.5. You’re responsible for the material in the textbook in those sections, and everything we’ve done in class. Here’s a bit more detail on the topics (though the fact that something is listed here doesn’t mean it will necessarily be on the exam and the fact that something isn’t mentioned here doesn’t mean it won’t be on the exam).

**Section 1.4:** You should know the Hierholzer and Fleury algorithms for finding Eulerian circuits, the definitions of Hamiltonian paths, cycles, and graphs, and the basic results in 1.4.4 for showing a graph is Hamiltonian. You should know Theorem 1.25.

**Section 1.5:** You should know the definitions of planar graph, regions, and a region being bounded by an edge. You should know Euler’s formula and understand how it can be used to show that, e.g., $K_{3,3}$ is nonplanar. You should know Theorem 1.33. I won’t ask about regular polyhedra (or, more generally, polytopes) on the exam, but you should know Kuratowski’s theorem.

**Section 1.6** You should know the definitions of coloring, chromatic number, and chromatic polynomial. You should know the basic bounds on chromatic number from Section 1.6.2, including Brooks’s Theorem, but I won’t ask you about the proofs. You don’t need to know about the clique number. You should know about the Four Color Theorem and the Five Color Theorem. (We went through the proof of the Five Color Theorem in class.)

**Section 2.1:** You need to know the Sum Rule and the Product Rule and how to apply them. Binomial coefficients are defined in this section, though they’re the main topic of Section 2.2. You should go through the examples in this section; they’re sort of the foundation of the rest of (enumerative) combinatorics.

**Section 2.2:** This section gives the formula for $\binom{n}{k}$, and proves the binomial theorem and various consequences of that theorem. The section also contains a number of identities involving binomial coefficients (e.g., “summing on the
upper index” and Vandermonde’s convolution), as well as some that are in the exercises. You don’t have to memorize all of these, though you should be generally aware of what kinds of identities there are—I’ll give you at least some hint if I think you need to know one of these identities for the exam.

Section 2.3: This covers multinomial coefficients. You should understand the combinatorial framework (choosing several sets of given sizes), know the algebraic definition, and the multinomial theorem. You should also know equation 2.17 that describes a multinomial coefficient as a product of binomial coefficients. (You should understand the combinatorial argument for this.)

Section 2.4: The pigeonhole principle is simple to state and something that you have probably encountered in other classes. You should know something about the ways it can be applied, as illustrated by the mathematical applications in this section. I won’t ask you to redo any of these, but I might ask you to do something similar to one of these, or to extend one. (If I do, I’ll remind you of the setup.)

Section 2.5: You should be able to use the principle of inclusion and exclusion in appropriate counting tasks, whether you’re asked to count the union of the subsets $A_i$ or to count the elements not in any $A_i$. You should understand the applications to the Euler $\varphi$ function and counting prime numbers that are described in the book, but I won’t ask you about chromatic polynomials. We went through the material on derangements carefully, and you should be able to apply that material.